(19) Europ[redacted]es Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 349 915 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 89111918.2

(51) Int. Cl.4: A61B 17/22 , G10K 15/06

(22) Date of filing: 30.06.89

The title of the invention has been amended (Guidelines for Examination in the EPO, A-III, 7.3).

(30) Priority: 01.07.88 CS 4771/88

(43) Date of publication of application: 10.01.90 Bulletin 90/02

(84) Designated Contracting States: DE FR NL

(71) Applicant: UNIVERZITA KARLOVA PRAHA
Ovocny trh 5
Praha(CS)

(72) Inventor: Sunka, Pavel
Rumburská 245
Praha(CS)
Inventor: Babicky, Václav, RNDr.
Na Slovance 29
Praha(CS)
Inventor: Barta, Zbysek
Jungmannova 30
Praha(CS)
Inventor: Benes, Jiri, MUDr. RNDr.
Kotovova 1836
Praha(CS)
Inventor: Kolácek, Karel, RNDr.
Vysocanská 47
Praha(CS)
Inventor: Kordac, Václav, Prof. MUDr.
Na Vinicnych horách 18
Praha(CS)
Inventor: Stuka, Cestmir, RNDr.
Pod prodejnou 6
Praha(CS)

(74) Representative: Patentanwälte Beetz sen. - Beetz jun. Timpe - Siegfried - Schmitt-Fumian- Mayr
Steinsdorfstrasse 10
D-8000 München 22(DE)

EP 0 349 915 A1

(54) Method of apparatus for adjusting the spark gap of a non-invasive lithotriptor.

(57) The proper distance of tips (3, 4) of electrodes of an aqueous spark gap of a generator of shock waves for non-invasive lithotrypsis is determined on the basis of measured time intervals required from the moment of starting of charging of the functional capacitor or from the moment of its partial charging up to the moment of discharge of the aqueous spark gap, which time interval has to be for a proper operation within limits of predetermined t_{min} and t_{max}.

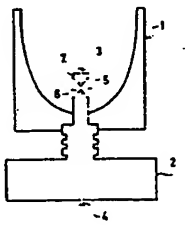

FIG. 2

METHOD OF ADJUSTING THE POSITION OF TIPS OF A SPARK GAP OF A GENERATOR OF SHOCK WAVES FOR NON-INVASIVE LITHOTRYPSIS AND ARRANGEMENT FOR THE EXECUTION OF SAID METHOD

The present invention relates to a method of adjusting the position of tips of a spark gap of a generator of shock waves for non-invasive lithotrypsis and to arrangements for execution of said method.

Focussed shock waves are applied utilizing arrangements for generation of shock waves for medical purposes, particularly for the non-invasive removal of kidneystones and bilestones. A repeated generation of shock waves is thereby accomplished by high voltage arc discharges in an aqueous spark gap. From this location a spherical shock wave propagates, which is concentrated into the focus by reflection from walls of a reflector represented by a hollow rotational ellipsoid.

Actually known arrangements of this kind as described for instance in DE-C-2,635.635; DE-C-3,316.837 and DE-C-3,543.881 do not enable a compensation of utilized tips of electrodes of the spark gap, which wear is caused in the course of passage of impulse currents of high amplitudes required for generation of shock waves. The life time of not regulated spark gaps is therefore relatively short. Spark gaps with adjustable tips are as a rule controlled mechanically, the method of their adjustment is however an empirical one and depends on the experience of the attendants. The major part of regulation methods bases therefore on the picking-up of distances or positions of tips of the spark gap and is capable to compensate roughly the reduction of electrodes. The change of geometry of the surface of electrodes which substantially influences the distribution of the electric field in the neighbourhood of tips of the spark gap and thus also the magnitude of the arc voltage can however not be taken into account by this method.

It is the object of the present invention to eliminate to a high degree said drawbacks and to provide a method and an arrangement which provide means for maintaining a correct operation of generators of shock waves for the mentioned purpose.

This object is achieved with a method and an arrangement respectively, as claimed. Dependent claims are directed on features of preferred embodiments of the invention.

According to the present invention the time interval from the start of charging or from a charged condition of a functional capacitor of the generator up to the moment of discharge within the aqueous spark gap is determined and basing on this obtained time interval, the adjustment of tips of the spark gap of the generator is accomplished.

The respective arrangement for execution of said method comprising two adjustable electrodes has both tips of electrodes situated within a housing provided with slots which determine a spatial angle for propagation of the shock wave, whereby the upper guiding means of the tip of the electrode has a conical shape with an apex angle corresponding to the angle of opening of the reflector. According to an alternative embodiment the arrangement can be provided with a mobile tip of the shape of a wire, opposite to which the upper guiding means of the tip of the other electrode of the shape of a cone with an apex angle corresponding to the angle of opening of the reflector is situated.

The main advantage of the method according to this invention and of the corresponding arrangement is the prolongation of the life time of the spark gap to a multiple of the life periods of existing spark gaps while securing a good capability of reproduction of individual shocks and thus achieving improvements of efficiency of healing. The spark gap with adjustable tips can be provided with means for picking-up their mutual position, with a proper regulation unit and with a working unit, for instance with an electro-mechanical transducer for adjustment of the position of tips of the spark gap. In case the indication from the pick-up device, determining the position of tips of the spark gap is transmitted to a display, it is possible to regulate the position of tips also manually. Against an arrangement described in DE-C- 3,543.881 the spark gap is designed slidable and against another known arrangement the spark gap is coaxial.

The method and the arrangement according to the present invention will be in the following described in detail with reference to the drawings, wherein

Fig. 1 shows a diagram of the voltage course of a spark gap for shock waves versus the time,

Fig. 2 and 3 indicate diagrammatically elevations of two embodiments of respective arrangements.

With reference to Fig. 1 which shows the voltage course of a spark gap for shock waves with indicated time intervals utilized for regulation, whereby U indicates the voltage on the spark gap, t the time in µs, we see that after an impulse charging of the functional capacitor, the voltage is slowly decreasing due to leakage over the resistance of the water of the spark gap. So far the time interval between the start of charging and the discharging over the aqueous spark gap is smaller than t_{min}, the discharge occured prior than the functional capaci-

tor has been sufficiently charged and the distance of electrodes has to be increased. If the time interval between the start of impulse charging and the discharge is larger than t_{max}, corresponding to the variability of the discharge voltage U, or in case no discharge is experienced, the distance of electrodes has to be reduced.

The regulation thus proceeds as follows. At the start of charging of the functional capacitor or from another defined condition of charging the time interval up to the moment of discharge is measured within the aqueous spark gap, or up to another moment connected directly to the discharge of the aqueous spark gap. This time information is utilized for an adjustment of the distance of the electrodes. If a short time interval between start of charging and discharging, where no full charging of the functional capacitor took place, the distance of tips of electrodes has to be increased. In case of a long time interval between start of charging and discharging of the spark gap where already a partial discharge of the functional capacitor took place, the distance of tips has to be reduced.

Example:

During the verification examinations of the arrangement a minimum time interval t_{min} of 40 µs and a maximum time interval of 300 µs has been determined. For up to 120 expositions of the shock wave the measured time interval did not depart beyond the time limit t_{min} - t_{max}. The distance of electrodes has been thereafter reduced by 0,2 mm. A following regulation has been subsequently accomplished only after 30 shocks.

The verification examinations have been performed as described in the Czechoslovacian certificate of authorship NO (application of an invention No. PV 7916-87) at a capacity of the discharge capacitor 1 µF at a voltage 10 kV. At these conditions 300 shocks have been needed for crushing a large bilestone.

The arrangement for execution of the method according to the present invention as shown in Fig. 2 comprises a reflector 1, to which a functional capacitor 2 is joined. The proper spark gap comprising an upper tip 3 and a lower tip 4, enclosed in a housing 5, which beyond its supporting function also supplies current to the upper tip 3, is situated in the focus of the ellipsoid of the reflector 1. The housing 5 is provided with slots 6 which determine the spatial angle for propagation of shock waves generated by the discharge in the spark gap. The upper guiding means 7 of the tip 3 of the electrode has the shape of a cone with an apex angle corresponding to the angle of opening of the reflector 1. At least one of electrodes of the arrangement is provided with shifting means (not shown).

Fig. 3 shows an alternative embodiment of the spark gap. The spark gap is situated in the reflector 1 and comprises a mobile tip 8 of wire shape opposite to which an upper guiding means 7 is situated having a conical shape with an apex angle corresponding to the opening angle of the reflector 1. The mobile tip 8 is provided with a sifting device (not shown).

The arrangements shown in Fig. 2 and 3 operate as follows. After the reflector 1 is filled with water and the patient is brought in contact with its upper part, the place for healing is properly adjusted whereafter between tips 3, 4 a discharge is generated by means of the functional capacitor 2, the power therefrom is transmitted by the focussed shock wave to the place where the healing of the patient has to be performed. In case of wear of the spark gap or of tips 3, 4 respectively, their adjustment is accomplished by the shifting device (not shown).

Claims

1. Method of adjusting the position of tips of a spark gap of a generator of shock waves for non-invasive lithotrypsis,
characterized in that
a time interval from the start of charging or from a charging condition of a functional capacitor is measured up to the discharge of the aqueous spark gap, whereafter the adjustment of tips of the spark gap is accomplished on the basis of the thus determined time interval.

2. Arrangement for execution of the method according to claim 1 provided with at least one adjustable electrode, characterized in that both tips (3, 4) of electrodes are situated in a housing (5) provided with slots (6) determining a spatial angle in which the shock wave is propagated, whereby an upper guiding means (7) of the tip of the electrode has a conical shape with an apex angle corresponding to the angle of opening of the reflector (1) and at least one of both electrodes is provided with a shifting device.

3. Arrangement as in claim 2 characterized in that it is provided with a mobile tip (8) of wire shape, opposite to which the upper guiding means (7) of the tip of the electrode is provided, having a conical shape with an apex angle corresponding to the angle of opening of the reflector (1), whereby the mobile tip (8) is provided with a shifting device.

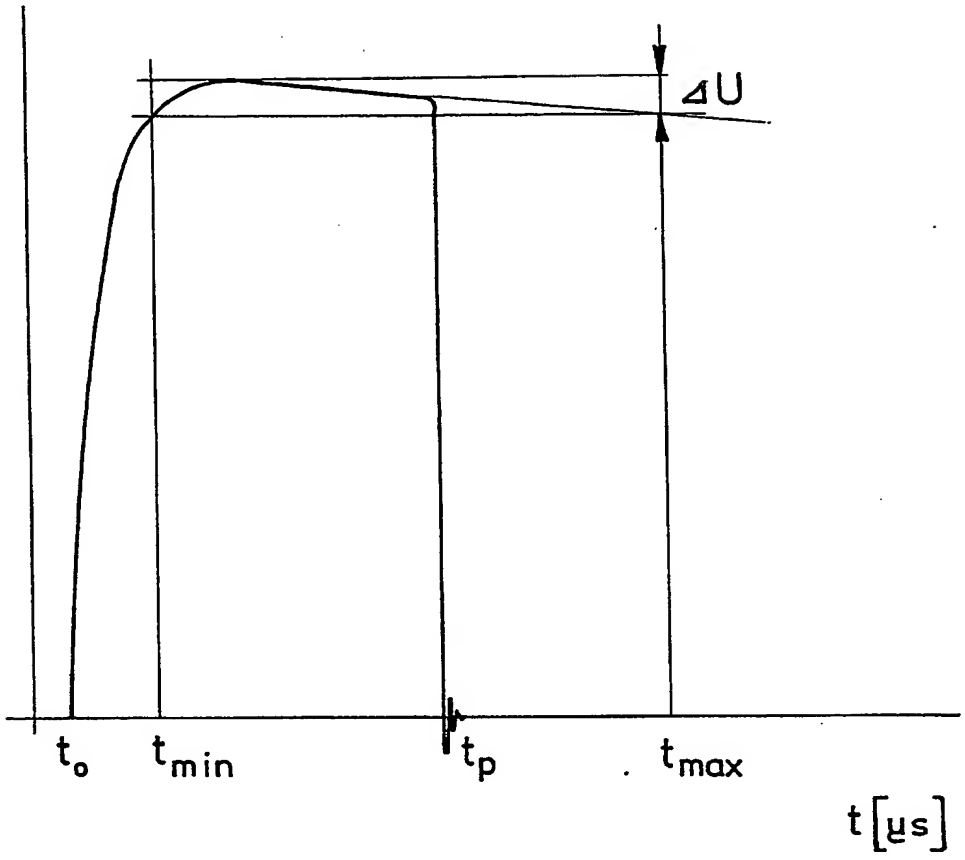

FIG. 1

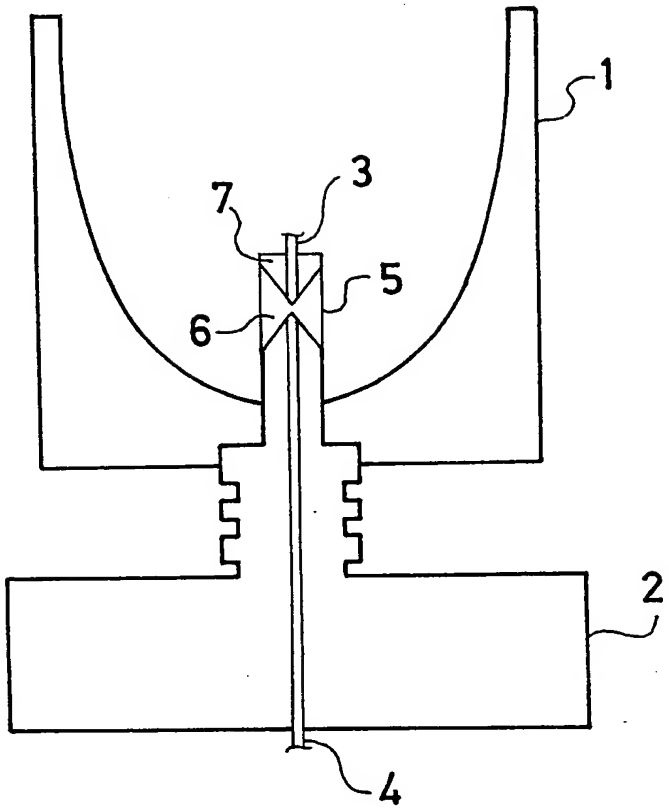

FIG. 2

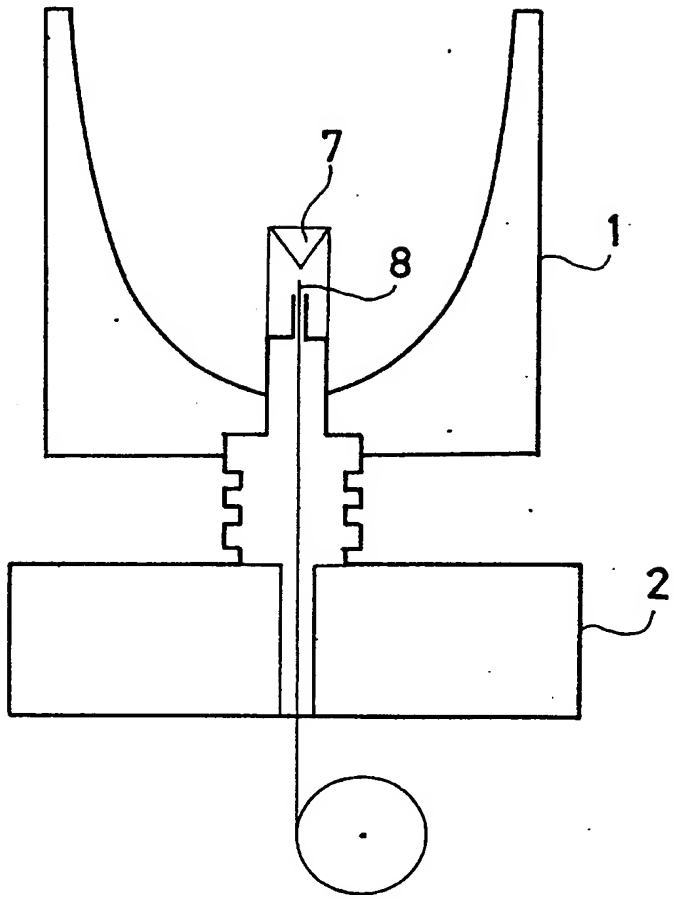

FIG. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 11 1918

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	FR-A-2 605 874 (UNIVERSITY KARLOVY V PRAZE) * Page 2, lines 22-30; figure 2 *	1,2	A 61 B 17/22 G 10 K 15/06
A	FR-A-2 593 382 (TECHNOMED INT.) * Page 8, lines 15-24; figure 1 *	1,2	
A	US-A-3 418 510 (MELHART) * Column 2, lines 22-31; figure 1 *	3	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

A 61 B
G 10 K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09-10-1989	MOERS R.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)